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Natural Resource Stewardship and Science

Mount Rainier National Park and Olympic National Park Elk Monitoring Program Annual Report 2013

Natural Resource Data Series NPS/NCCN/NRDS—2014/642

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Elk in the Upper Dosewallips, Olympic National Park, WA.
Photography by: Patti Happe, Olympic National Park.

ON THE COVER
Elk in Mount Rainier National Park, WA.
Photograph by: Muckleshoot Indian Tribe.

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Executive Summary

Fiscal year 2013 was the third year of implementing an approved elk monitoring protocol (Griffin et al. 2012) in Mount Rainier (MORA) and Olympic (OLYM) National Parks in the North Coast and Cascades Network (NCCN). However, it was the sixth and fourth year of gathering data according to protocol in MORA and OLYM respectively; data gathered during the protocol development phase followed procedures described in the protocol. Elk monitoring in these large wilderness parks relies on aerial surveys from a helicopter (Figure 1). Summer surveys are intended to provide quantitative estimates of abundance, sex and age composition, and distribution of migratory elk in high elevation trend count areas.

An unknown number of elk is not detected during aerial surveys; however the number of missed elk may be estimated by applying site-specific models that account for detection bias (Griffin et al. 2012). Detection bias for elk surveys in MORA was estimated using a model developed from survey data collected from 2008-2010, making use of elk that were previously equipped with radio collars by cooperating tribes. At the onset of protocol development in OLYM there were no radio-collars on elk. Consequently the majority of the effort in the OLYM from 2008-2011 was focused on capturing and radio-collaring elk and conducting sightability trials needed to develop a detection bias model for OLYM. In this annual report we provide estimates of abundance and composition of elk observed in MORA, present raw counts of elk observed in OLYM, and describe sightability trials conducted in OLYM.

At MORA the North trend count unit was surveyed twice and the South unit was surveyed once. We counted 263 and 106 elk during the replicate surveys of the North Rainier trend count area, and 505 elk in the South Rainier trend count area. Using the model to correct for detection bias, we estimated that 311.9 and 160.8 elk were in the North trend count area, and 600.2 elk were in the South trend count area at the time of the respective surveys.

Two trend count areas at OLYM, the Core and Southeast, were surveyed completely. We counted 236 elk in the Core and 90 in the Southeast. In addition, we surveyed a portion of one survey unit twice specifically to collect detection bias data for double-observer sightability trials. Eight collared elk groups were detected for the trials in 2013, bringing the total to 47 double-observer sightability trials in OLYM and thus completing the data acquisition phase for OLYM detection bias model development.

Figure 1. Elk in the Upper South Fork Hoh, Olympic National Park, WA. Photography by: Patti Happe, Olympic National Park.

Acknowledgments

Elk monitoring in Mount Rainier National Park and Olympic National Park is a component of the North Coast and Cascades Network of National Parks Inventory and Monitoring (I&M) Program (Weber et al. 2009). The program in FY2013 was scheduled to receive direct NCCN funding, however due to budget cuts to the I&M program that funding was not forthcoming. Flights in OLYM were paid for by the NCCN Science and Learning Network, Olympic National Park, and Washington's National Park Fund; in MORA funding was provided by the NCCN Science and Learning Network, NPS base funds, Washington's National Park Fund, Muckleshoot Indian Tribe (MIT), Puyallup Tribe of Indians (PTOI), and Washington Department of Fish and Wildlife (WDFW). In addition staff time and data management support was provided by the NCCN I&M program and MORA, OLYM, and U.S. Geological Survey (USGS). The Lower Elwha K'lallam Tribe (LEKT), the Point-no-Point Treaty tribes, the Quinault Nation and WDFW assisted with capturing elk and placing out additional radio collars that were used in OLYM. The National Park Service (NPS) is grateful to the MIT, PTOI, and WDFW for their long-standing support for elk monitoring in Mount Rainier National Park, and for being full partners in the development and implementation of the monitoring protocol. Each of these partners contributed substantial funding and personnel in support of aerial surveys, as well as experience and ideas critical to developing and testing the protocol for elk monitoring in these parks. We would like to thank P. Griffin and K. Jenkins (USGS Forest and Rangeland Ecosystem Science Center) for their role in working with all the partners to develop the elk monitoring protocol for the surveys reported here, and B. Lubow (Colorado State University) for his help developing analytical components of the protocol. The authors thank the other crew members who participated in surveys including K. Beirne, B. Baccus, R. Lofgren, R. Lechleitner, T. Suess, G. Kessler, J. Mongtomery (NPS); M.Middleton, M. McDaniel, E. Anderson (MIT); D. Coats (PTOI); T. Schmidt, B. Hoenes, B. George, S. Berge (WDFW). We thank the following pilots for their assistance: J. Hagerman, R. Olmstead, D. Uttecht (Northwest Helicopters), and C. Cousins (Olympic Air). For their support of the elk monitoring program, we thank Muckleshoot Indian Tribe (MIT) Wildlife Committee, P. Dillon (PTOI), K. Sager-Fradkin (LEKT), and P. Geissler (USGS National Park Monitoring Project). We are grateful to B. Baccus, K Beirne, P. Griffin, and K. Jenkins for reviews of the draft report.

Introduction

Elk populations are key components of lowland and montane ecosystems in MORA and OLYM, and are tightly woven into each park's historical and cultural fabrics. Historical accounts indicate Roosevelt elk (*Cervus elaphus roosevelti*), the Pacific coastal subspecies of elk, were abundant in primeval floodplains and riparian forests along many of the major river systems in western Washington. During summer many herds migrated to subalpine meadows of adjoining mountain chains (Schwartz and Mitchell 1945, Starkey et al. 1982, Taber and Raedeke 1980). Although the ethnographic record clearly indicates that elk were hunted by Native Americans and are indigenous to both the Olympic and Cascades Ranges, early distribution patterns of elk in the Cascades are poorly understood. It is widely acknowledged that elk had become quite rare or absent around Mount Rainier in early historical times for reasons that are not known (Gustafson 1983, Schullery 1983). By the start of the 20th century, unregulated market hunting of elk for meat, antlers, and trophy 'ivory' teeth had widely decimated elk populations throughout the most accessible and settled areas of Oregon and Washington (Graf 1955, Murie 1951). A notable exception was on the Olympic Peninsula where a largely inaccessible wilderness helped to protect a remnant stronghold of native Roosevelt elk.

Elk in Mount Rainier National Park

MORA was created in 1899 to preserve natural wonders of the volcano (Mount Rainier) and its surroundings, and to protect fish and game. Because the park was established largely to protect the mountain, it encompasses mostly montane forests and high elevation subalpine and alpine environments used by elk as summer ranges, but not the majority of low-elevation winter ranges in the adjoining river valleys. Although the native elk had been largely, if not completely eliminated from MORA by 1899, elk populations were reestablished through several translocations of Rocky Mountain elk (*Cervus elaphus nelsoni*) from Yellowstone and Grand Teton National Parks to lands adjacent to the park in 1912-1915 and 1932-1933 (Bradley 1982). Wildlife observation cards maintained at MORA and summarized by Bradley (1982) indicated that by 1915 elk were observed in Grand Park (i.e., the northern part of MORA) just a couple of years following the first releases, and that by the 1930's they had dispersed widely to inhabit the primary summer ranges used by elk today.

From 1950 to the 1970's intensive logging of elk winter ranges adjoining MORA improved winter and spring foraging conditions for elk and stimulated population growth of migratory elk herds that wintered adjacent to the park and summered within (Raedeke and Lehmkuhl 1985, Jenkins and Starkey 1996). In 1962, a U.S. Forest Service biologist counted 466 elk on subalpine meadows within MORA, prompting initial concerns over the potential impacts of elk on subalpine meadows, one of the park's premier natural resources. As elk populations continued to grow during the 1970's and signs of trailing, trampling, and grazing impacts drew greater attention, the following questions assumed primary importance to park managers (Starkey 1984): (1) are the elk native to the park; (2) is the elk population growth a natural ecological process; (3) what changes can be expected into the future; and (4) are the elk having lasting impacts on subalpine vegetation? As a direct response to these growing management concerns, the NPS and several university research cooperators conducted

studies of elk history and ethnography in the Mount Rainier ecosystem (Bradley 1982, Gustafson 1983, Schullery 1983), elk distribution and ecology (Bradley 1982, Cooper 1987), elk taxonomy (Schonewald-Cox 1983), land-use and forest succession on winter range (Jenkins and Starkey 1996), and grazing and trampling impacts on subalpine summer ranges (Bradley 1982, Ripple et al. 1988, Motazedian and Sharrow 1984, Sharrow and Kuntz 1986). Primary conclusions of this collective work were that elk were native to the area (Gustafson 1983), and that subspecific differences in the Rocky Mountain elk that were reintroduced near the park were not sufficiently distinctive to consider the present population non-native or exotic (Schonewald-Cox 1993, Starkey 1984). It was concluded that elk populations using the park during summer are influenced by logging practices on adjoining winter ranges, but that post-logging forest succession patterns had reduced forage availability on the winter range and ameliorated population growth trends by the late 1980's (Jenkins and Starkey 1996). Although trailing and trampling impacts were locally important (Bradley 1982, Ripple et al. 1988), grazing impacts were not clearly demonstrated (Sharrow and Kuntz 1986). Because elk are such important drivers of ecosystem change, however, it was suggested that long-term monitoring of both subalpine vegetation and elk populations should be sustained indefinitely (Starkey 1984). Elk monitoring in MORA has continued from 1974 to present day.

Elk in Olympic National Park

OLYM was created first as Mount Olympus National Monument in 1909 by Theodore Roosevelt for the explicit purpose of protecting the last stronghold of Roosevelt elk and its native forested habitat following the large-scale decline in elk populations. Although elk were very abundant throughout the Olympic Peninsula in early historical times, by the turn of the 20th century only 3,000 remained, primarily in the central core of the Peninsula that is currently OLYM (Morganroth 1909). Mount Olympus National Monument was expanded and re-created as OLYM in 1938 to "provide suitable winter range and permanent protection for herds of native Roosevelt elk" (U.S. Congress 1938). Because elk were central to the creation of the park, its boundaries represent as complete an ecological system as was possible when the park was created, including both subalpine summer ranges of elk in the park's mountainous interior, and the many low-elevation river valleys used as winter range. Today the park is internationally recognized by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as a Biosphere Reserve and a World Heritage Site.

The creation of Mt. Olympus National Monument was just one of several coordinated measures to protect dwindling elk herds throughout Washington in the early 1900s. In addition to the efforts to restock former big game ranges in other areas of the state (i.e., the Mount Rainier ecosystem), elk were protected through a moratorium on hunting, and through an aggressive campaign against predators. A bounty was placed on wolves and cougars, which reduced predation on elk, and ultimately led to the eradication of wolves on the Olympic Peninsula by the late 1920's (Scheffer 1995).

Elk populations responded favorably to multifaceted protection on the Olympic Peninsula. As early as 1915, there were reports of 'overbrowsing' in the western rainforest valleys of the Mt. Olympus National Monument, and large numbers of elk were reported dying during severe winters (Schwartz 1939). During the 1930's, several U.S. Forest Service and NPS biologists examined elk ranges

throughout the park and reported concerns about overgrazing in low-elevation winter ranges within the temperate rainforests (Murie 1935a, Murie 1935b, Sumner 1938, Schwartz 1939). Twenty years later, Newman (1958) noted that the range was not severely over used and that the elk population was stable because of the "rapid and regular seasonal growth of forage plants, even pressure from predators, and natural die-offs".

Elk continue to play an important ecological role in both MORA and OLYM – as architects of plant communities, drivers of ecosystem processes, and sustainers of diverse communities of predators and scavengers. In addition to these important ecological roles in the ecosystem, elk in both parks are significant to hundreds of thousands of visitors annually who travel to these parks with the hope of viewing elk in their natural environment.

Land use, hunting, and predator management programs on lands adjacent to these parks have the potential to influence elk population trends and ecosystem dynamics within the parks. Information on ungulate population trends has important management significance in NCCN parks through its influence on internal park management decisions, and the ability of the NPS to work effectively with land and wildlife managing agencies and local Native American Tribes in establishing common management goals and objectives outside the park's boundaries. Furthermore, interpreting the status, trends, and ecological significance of park resources to an interested public is an important function of the National Park Service.

Monitoring Objectives

There are two specific objectives of the MORA and OLYM elk monitoring protocol.

> **Objective 1**: Monitor trends in elk abundance, distribution, and composition in selected subalpine summer ranges in MORA and OLYM.
>
> **Objective 2:** Monitor trends in elk abundance and distribution in selected low-elevation winter ranges in OLYM.

Survey and Reporting Objectives for 2013

This annual report for the MORA and OLYM elk monitoring program is for administrative purposes; data are summarized and presented without extensive analysis or interpretation. The elk monitoring protocol (Griffin et al. 2012) calls for providing reports that contain more comprehensive data analysis every four years, including quantified estimates of variance and trends, and interpretation of those data. A 4-year report that will examine trends in counts obtained from 2008-2011 is scheduled to be completed in 2013.

The objectives of this report are to summarize results of elk surveys conducted in selected subalpine summer ranges in MORA and OLYM during summer 2013. The 2013 surveys were the third ones conducted since the protocol for aerial surveys in MORA and OLYM was approved for implementation in 2011 and published in 2012 (Griffin et al. 2012). The protocol calls for reporting flight conditions and raw counts of elk obtained from annual surveys in both parks, as well as estimates of elk abundance corrected for detection biases in Mount Rainier.

Based on the monitoring protocol and agreement of all the monitoring partners in MORA, the survey objectives in 2013 were to complete two replicate surveys of the summer range of the North Rainier Herd and a single survey of the South Rainier Herd summer range. Results of the 2013 surveys are reported here, including raw counts and counts adjusted for detection bias.

The 2013 survey objectives for OLYM were to complete surveys of elk within two trend count areas (Core Area and Southeast Unit), while also collecting sightability trial data that will be used to complete development of a double-observer sightability model for OLYM. The double-observer sightability model used to adjust raw counts for detection biases has not been completed for OLYM. Sightability model development in OLYM lagged behind that of MORA due to the lack of pre-existing radio collars on elk at the onset of the protocol development phase in OLYM (Griffin et al. 2012), as well as the mass failure of GPS collars deployed in OLYM in 2009 (Griffin et al. 2011) and the partial failure of GPS collars deployed in 2010 (Happe et al. 2013).

Due to budgetary constraints, winter range surveys in OLYM were suspended in 2011. Following the monitoring protocol, the winter range surveys in OLYM are treated as a legacy dataset, and additional surveys will be conducted in the future only as funding allows (Griffin et al. 2012).

Study Area

In MORA, the two trend count areas include all of the subalpine habitats in the park that are encompassed by an arc around the volcano from Vernal Park in the north, to Chinook Pass at the east, and south through the Tatoosh Range (Figure 2). These trend count areas include the primary subalpine summer ranges of the North Rainier Herd and South Rainier Herd.

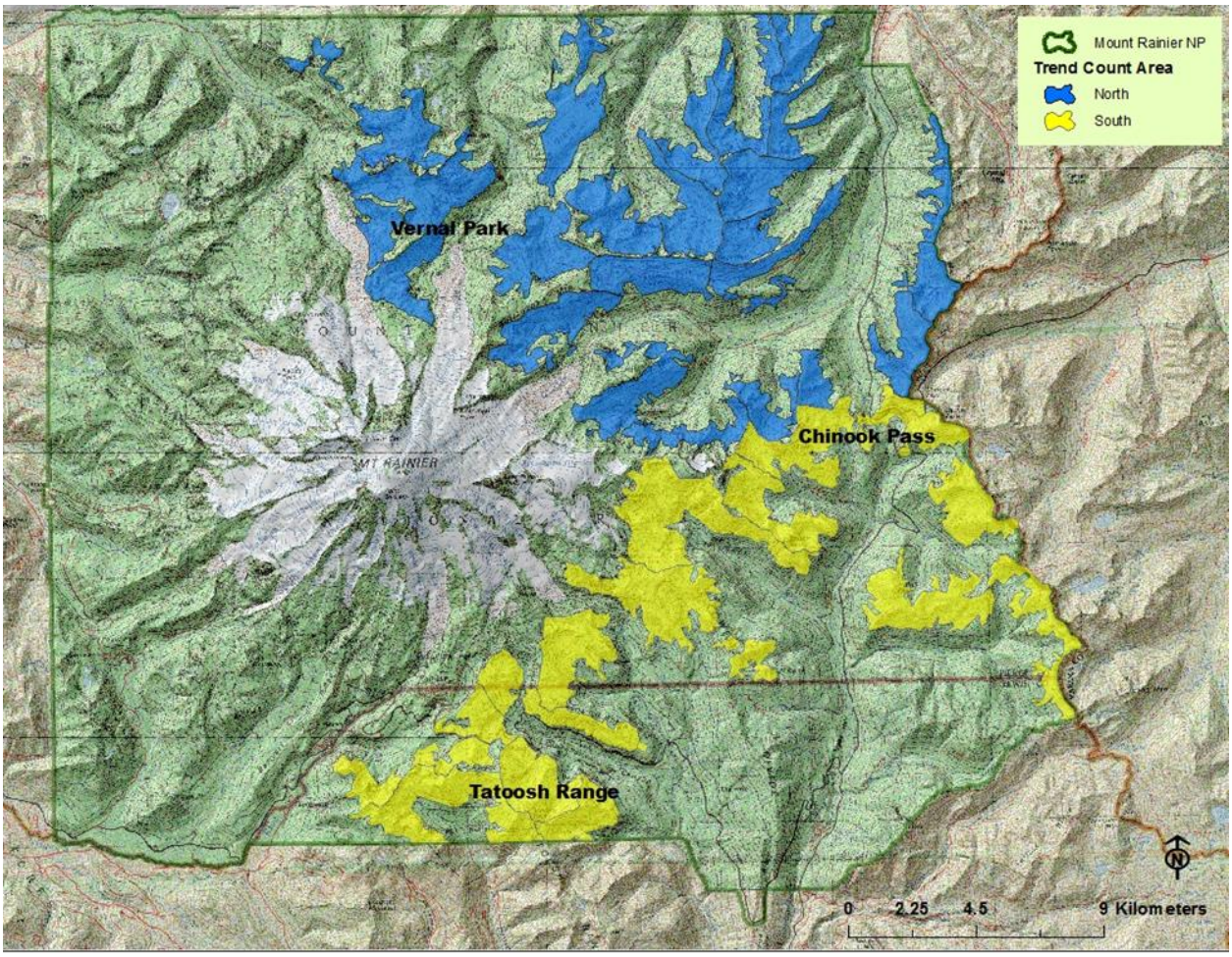

Figure 2. Summer trend count areas within Mount Rainier National Park. The North Rainier trend count area is approximately 103 km2, and the South Rainier trend count area is approximately 89 km2.

In OLYM the majority of the summer range for migratory elk is divided into five trend count areas. The Core area corresponds with summer range of migratory herds of elk that winter in the primary low-elevation winter ranges in the Hoh and Queets Valleys (Schwartz and Mitchell 1945, Olympic National Park, unpublished data). The four ancillary summer range trend count areas (Figure 3) encompass the majority of the remaining migratory elk populations in the Park. Elk in the Quinault, Elwha and Northwest trend count areas winter in OLYM, whereas elk in the Southeast trend count area migrate out of OLYM and winter near the Hood Canal.

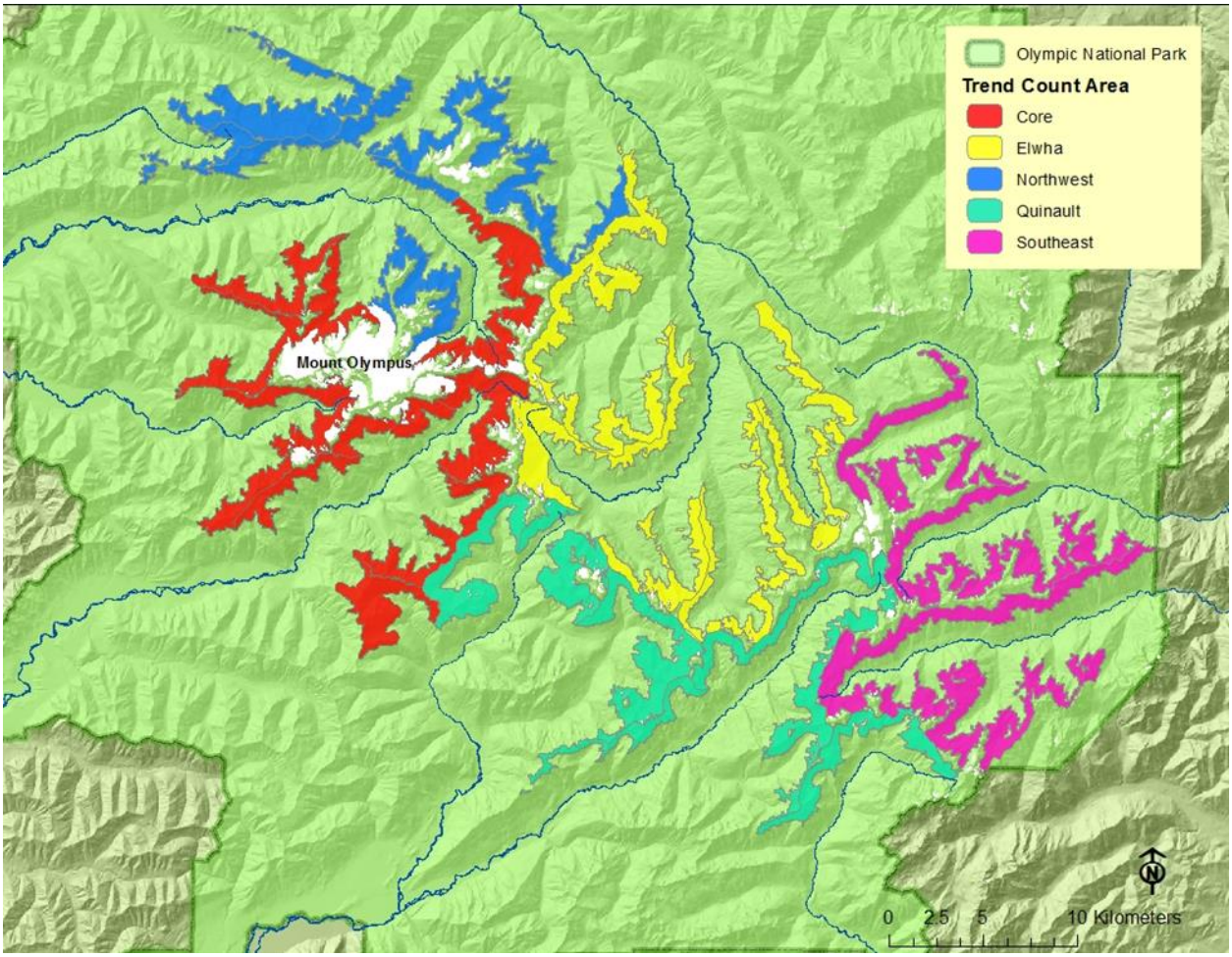

Figure 3. Summer trend count areas within Olympic National Park, including the annually-surveyed, Core trend count area, and four ancillary trend count areas surveyed once every four years. The Core and four ancillary trend count areas: Elwha, Northwest, Quinault, and Southeast are approximately 100, 81, 73, 79, and 86 km2, respectively.

Methods

The sample design, survey methods, and analytical framework for elk monitoring are presented in detail in the elk monitoring protocol for MORA and OLYM (Griffin et al. 2012). Salient features are summarized below.

Safety

All helicopter survey operations strictly followed helicopter use aviation safety plans, prepared specifically for each survey.

Sample Design

The summer trend count areas established in MORA (Figure 2) and OLYM (Figure 3) comprise most of the subalpine summer ranges used by elk in each park. We defined trend count areas on the basis of elevation and forest canopy cover. Within the elevation boundaries of trend count areas, we used each park's vegetation cover map (Pacific Meridian Resources 1996) and data gathered during earlier surveys to identify and exclude areas of continuous dense forest canopy cover or rock and snow. In MORA, trend count areas were bounded by elevations below 2100 m and above 1500 m for the North trend count area, and by elevations below 2100 m and above 1350 m for the South Rainier trend count area, except that on the SW facing slopes of Stevens Ridge and Shriner Peak we surveyed down to 1200 m. In OLYM, the majority of the summer trend count areas ranged between 1200 m and 1650 m.

The sampling design calls for completing one replicate survey of both trend count areas in MORA, with an additional replicate of one of the survey areas alternating between years. In 2013 the North was surveyed twice and the South once. Surveys in MORA are conducted in the 4 hours before sunset. In OLYM two trend count areas are surveyed once each year, with the Core area flown each year and one of the other four areas selected on a 4 year rotation. Surveys are flown either 4 hours after sunrise or 4 hours before sunset. All surveys in both parks are to be completed between 15 August and 15 September.

Experience has shown that it is not possible for a single helicopter to effectively survey all of the North Rainier trend count area or all of the South Rainier trend count area in one evening (Griffin et al. 2012). A similar issue exists in OLYM, where it is not always possible to complete a count area in a single morning. Therefore, it has been necessary to either survey a trend count area over two days or to use two helicopters operating simultaneously to complete the surveys. A stated goal of project participants in the MORA surveys is to use two helicopters operating simultaneously, but this is not always possible due to limitations in helicopter availability and crew scheduling. Consequently, the protocol reflects discussions of all the project partners recognizing that surveys may be completed on multiple days as logistics require (Griffin et al. 2012). The complementary halves of the survey areas in MORA have been developed to minimize the movements of elk across boundaries that are counted on different days and to maximize safety in cases where two helicopters may be operating simultaneously. Any movement of elk across boundaries of areas surveyed on multiple days would increase variance of counts, but would not introduce a systematic bias that would influence trend analysis.

We have also discovered that for a variety of logistical reasons, it has not always been possible to survey elk in all of the subunits that comprise a single trend count area. Among the logistics problems encountered are: high winds, clouds or fog that develop during a survey, mechanical problems with helicopters, and temporal constraints associated with darkness. In addition, in years or areas where we were gathering resight data for model development, time spent on radio-telemetry locating missed elk negatively impacted our ability to completely survey all units. We will evaluate the effects associated with missed survey units within trend count areas during the 4-year comprehensive analysis scheduled soon to be completed.

Survey Methods

A crew of a pilot and three observers counted elk from a type-III helicopter; helicopters used in 2013 were a Bell 206B-3, MD 500D and MD 530. Trend count areas were thoroughly searched in their entirety for elk from approximately 150 m (500 feet) above ground level, with flight lines approximately 250-500 m apart. We recorded the location and group size of all elk groups detected, as well as other covariate data used in estimating aerial survey detection bias. In-flight protocols for the double observer method required all observers to act independently in searching for and detecting elk groups. After reconciling which independent observers detected each observed group of elk, all observers collaborated in determining group size, composition and covariates of detected groups. An elk group was defined as one or more elk in close proximity. Any large group was photographed with a high resolution digital camera when possible (Schoenecker et al. 2006); later, the group size or composition data, or both, were updated if examination of the photo yielded a more complete count. In addition, all other wildlife species seen on the flighs were recorded (Appendix1, Appendix 2).

Double-Observer Sightability Trials in OLYM

Double-observer sightability trials are attempts by aerial survey crews to detect elk groups containing at least one radio-collared elk. These trials are used to model the probability that aerial survey crews detect elk groups of different sizes under different survey conditions. These estimated detection probabilities, in turn, are used to adjust raw counts of elk to better estimate the true number of elk present within a survey area.

In OLYM, we continued to collect double-observer sightability trials in 2013 to contribute data for sightability model development. During the surveys we used radio-telemetry to determine if there were any radio-collared elk within each of the elk groups observed. Following the surveys, we also determined locations and covariate values for any radio-collared elk that were not detected during the survey. The complete set of detailed sampling protocols is provided in Griffin et al. (2012).

In developing the double-observer sightability model, we captured and radio-collared 55 elk from 2008-2013, deploying 43 GPS and 14 VHF collars (two elk were captured twice). Ten elk were captured and collared in 2008, 20 in 2009, 18 in 2010, five in 2012, and four in 2013. We had 12 fully or partially functional radio collars available for resights in 2013; 24 GPS radio collars have failed, 14 elk have died, three elks' fate is unknown (dead or dead collar), and four elk are non-migratory and hence were not available for resights during summer range surveys.

Data Management

Following each survey flight the observers immediately reviewed all data forms and corrected any discrepancies. A GIS Specialist downloaded GPS data of helicopter flight lines to the NCCN project workspace on an OLYM computer server. In MORA, the tribal and WDFW biologists provided copies of their completed data forms, the associated GPS files for the helicopter flight path, and any photographs of large elk groups to the MORA project manager. After the flights the project manager, participating wildlife biologist, or technician examined the photos; if inspection of photos led to a revision for group size or composition, then the pertinent photos were annotated and saved, and changes made to the data forms.

The OLYM and MORA project managers entered survey data into the elk project database. After data were entered, quality review included verification, which entailed confirming that data in the database were accurate with respect to the field forms. Next, data were checked for consistency, and all data entered were confirmed to be within acceptable bounds (steps that will be automated in the final project database using queries).

Data Analysis

We summarized data according to the template provided in Griffin et al. (2012). Results of surveys are presented here without detailed analysis. Variance estimates, along with more complete analyses of spatial distribution, and trends in abundance and composition, will be part of the 4-year analysis.

Results

2013 Climate in Review

Spring and summer conditions in 2013 were warmer and drier than in previous three years; snow water equivalent (SWE), measured on 1 May 2013 at Waterhole in OLYM, was 132% of the 30-year normal (1981-2010). At Paradise in MORA, the May 1st snow water equivalent was 120% of normal. A warmer than normal June and July helped accelerate the melting of the snow-pack. Snow cleared from reference sites at OLYM and MORA just beyond the average date of meltout (five and two days respectively). High elevation areas experienced unusually dry condtions in July and most of August and mountain temperatures remained above normal. Despite this, plant phenology appeared within prescription during the survey period (Figure 4). Grasses and sedges remained green with no indications of senescence (yellowing). Likewise, heath, huckleberry and willow shrubs showed little indication of fall color change.

Figure 4. Snowmelt and phenology in 2013 was within prescription, as illustrated by the phenology photo points at a) Buck Lake (Mount Rainier National Park 8/19/2013), b) Fan Lake (Mount Rainier National Park 8/21/2013), c) Swimming Bear Lake (Olympic National Park 8/27/2013), d) Lake Billey Everett (Olympic National Park 8/27/2013).

Names and Roles of Project Personnel

Patti Happe served as the Project Lead in this study and also as the project manager for OLYM. Mason Reid served as the project manager for MORA. David Vales was the wildlife biologist for Muckleshoot Indian Tribe (MIT). Barbara Moeller was the wildlife biologist for Puyallup Tribe of Indians (PTOI). Michelle Tirhi and Pat Miller were the wildlife biologists for Washington Department of Fish and Wildlife (WDFW) Region 6 and Region 5, respectively. Other survey personnel that took part in spring and summer surveys are listed in Table 1.

Table 1. Observers that participated in elk surveys in 2013. Personnel are identified by the tribe or agency with which they are affiliated.

Affiliation	Names
National Park Service	Patti Happe, Mason Reid, Kathy Beirne, Bill Baccus, Rebecca Lofgren, Todd Suess, Glenn Kessler (Survey crew members); Bill Baccus, Katherine Beirne, Rich Lechleitner, James Montgomery (helicopter managers)
Muckleshoot Indian Tribe	Mike Middleton, David Vales, Eric Anderson, Mike McDaniel
Puyallup Tribe of Indians	Barbara Moeller, D. Coats
Washinton Department of Fish and Wildlife	Tammy Schmidt, Michelle Tirhi, Brock Hoenes, Brooke George, Stephanie Bergh, Scott McCorquodale
Pilots	Rob Olmstead, Jess Hagerman, Doug Uttecht, Kurt Cousins

Flight Statistics

Mount Rainier Summer Surveys

With anticipated biennial funding from NCCN, the monitoring partners decided to alternate double-replicate surveys among the North and South survey areas, with a single replicate of the alternate survey area. Support for the 2013 flights in MORA came from the NCCN Science and Learning Network, MORA, Washington's National Park Fund, WDFW, MIT and PTOI. Although the helicopter costs of elk surveys were not funded by the NCCN Inventory and Monitoring Program in 2013, we stuck with the survey schedule listed in the protocol. In 2012 we conducted two surveys in the South survey area and one survey in the North survey area (Happe et al. 2013). For 2013, the group completed two replicate surveys of the North Rainier trend count area and one replicate survey of the South Rainier trend count area (Table 2).

The first replicate survey for the North Rainier trend count area was scheduled for 15 August, however it was cancelled due to heavy clouds. Complete surveys were flown 4 days later on 19 August, the planned backup date. A second replicate survey was attempted on 9 September, however it was aborted after takeoff due to high temperatures (24C) and glare. No elk were seen by either helicopter crew in over an hour of flying. Funding for the makeup flight was not available until 19 September. Although this date was after the protocol date of 15 September, we felt that the generally cool, wet conditions we experienced in most of September would allow an acceptable count, and the second replicate North survey was completed. The survey for the South Rainier trend count area was conducted successfully on 21 August.

Table 2. Flight details for summer 2013 surveys at Mount Rainier National Park. Last names of pilots are indicated in bold font.

Flight	Date	Replicate	Survey Units	Total flight time (h:min)	Survey time (h:min)	Sponsor[1]	Crew Members
1	Aug 19	First North	N4, N5b, N7, N8, N11, N12, N13, N14, N15	2:41	2:32	NPS	Beirne,Lofgren, Reid,**Olmstead**
2	Aug 19		N1, N2, N3, N5a, N6, N9, N10, N16, N17, N18	2:43	2:25	WDFW	Hoenes, Schmidt, Tirhi, **Hagerman**
3	Aug 21	First South	S1, S4, S5, S6, S7, S9, S17, S18, S19, S20	3:00	2:36	WDFW	Bergh, George, McCorquodale, **Hagerman**
4	Aug 21		S8, S10, S11, S13, S14, S15, S16	3:03	2:56	PTOI	Beirne, Coats, Moeller, **Olmstead**
5	19 Sep	Second North	N1, N2, N3, N5a, N6, N9, N10, N15, N16, N17, N18	2:35	2:31	MIT	Anderson, McDaniel, Middleton, **Cousins**
6	19 Sep		N4, N7, N8, N11, N12a,	1:28	1:19	NPS	Beirne, Lofgren, Reid, **Uttecht**
7	19 Sep		N5b, N12b, N13, N14	0:48	0:40	NPS	Beirne, Lofgren, Reid, **Uttecht**

1 Sponsors are the Tribe or agencies responsible for funding the helicopter costs. NPS - National Park Service, Mount Rainier National Park, MIT - Muckleshoot Indian Tribe, PTOI - Puyallup Tribe of Indians, WDFW - Washington Department of Fish and Wildlife.

Olympic National Park Summer Surveys

Support for the 2013 flights in OLYM came from the NCCN Science and Learning Network, Olympic National Park, Washington's National Park Fund and the GPS radio collar manufacturer (reimbursement for failed collars). We originally planned to conduct up to nine flights over 3½ days in the Core and the Quinault trend count areas, with additional surveys in the Elwha, Southeast, and Northwest as needed in order to collect at least 10 resight data points. Prior to the onset of the surveys, all migratory GPS-collar-equipped elk were detected as consistently using high elevation summer range (NPS, unpublished data). For collecting resight data of migratory elk, we had seven fully functional GPS collars and five additional collars with fully or partially functioning, very high frequency (VHF) radio signals that could be located using traditional radio telemetry.

A weather front moved into the area the week of the surveys, making it necessary to adjust survey coverage and extend the survey period. We extended the stay of the helicopter to 5 days and by the end of the week we were able to conduct six flights during portions of 3 days (Table 3): three during the morning hours and three in the evening. Two of the evening flights (flights 3 and 4) were curtailed due to deteriorating weather. Persistent low clouds and light rain in the Quinalt area precluded complete surveys in that area, consequently we changed plans and conducted surveys in the drier Southeast trend count area. Survey conditions prevented conducting many additional flights for gathering resight data. We completed the surveys on Friday evening as the helicopter was on its

return ferry to its home base. We were successful, however in conducting complete surveys of the Core and the Southeast and two resight surveys in the Elwha.

Table 3. Flight details for summer 2013 surveys at Olympic National Park. Last names of pilots are indicated in bold font.

Flight	Date	Replicate[1]	Survey Units	Total flight time (h:min)	Survey time[2] (h:min)	Crew Members
1	Aug 27	1	C1, C2, C3, C4	2:27	1:53	Baccus, Beirne, Happe, **Olmstead**
2	Aug 27	1	C5, C6a, C6c	2:05	1:11	Baccus, Beirne, Happe, **Olmstead**
3	Aug 27	1,0	C6b, C6d, E3	1:31	0:47	Beirne, Happe, Suess, **Olmstead**
4	Aug 28	1,0	C7, E3	1:24	0:36	Baccus, Beirne, Happe, **Olmstead**
5	Aug 30	1	SE2, SE3	1:52	1:16	Baccus, Beirne, Happe, **Olmstead**
6	Aug 30	1	SE1	2:03	1:22	Baccus, Beirne, Happe, **Olmstead**

[1] Replicate = 0 are flights just flown for gathering resight data, and are often not complete counts of units.

[2] Excludes time spent on telemetry and ferrying between survey units.

Elk Observations

Mount Rainier Summer Surveys

Figures 5 through 7 show the survey paths (flight lines) flown during the summer surveys in MORA. Observed counts of elk groups in MORA are summarized in Table 4. We saw 263 elk in 40 groups in the first North trend count area replicate counts, and 106 elk in 34 groups on the second replicate. The mean group size was greater in the first count (6.6) with the largest group being 59 elk. In the South trend count area 505 elk in 80 groups were observed; the average groups size was 6.3 elk, and the largest group seen contained 111 elk.

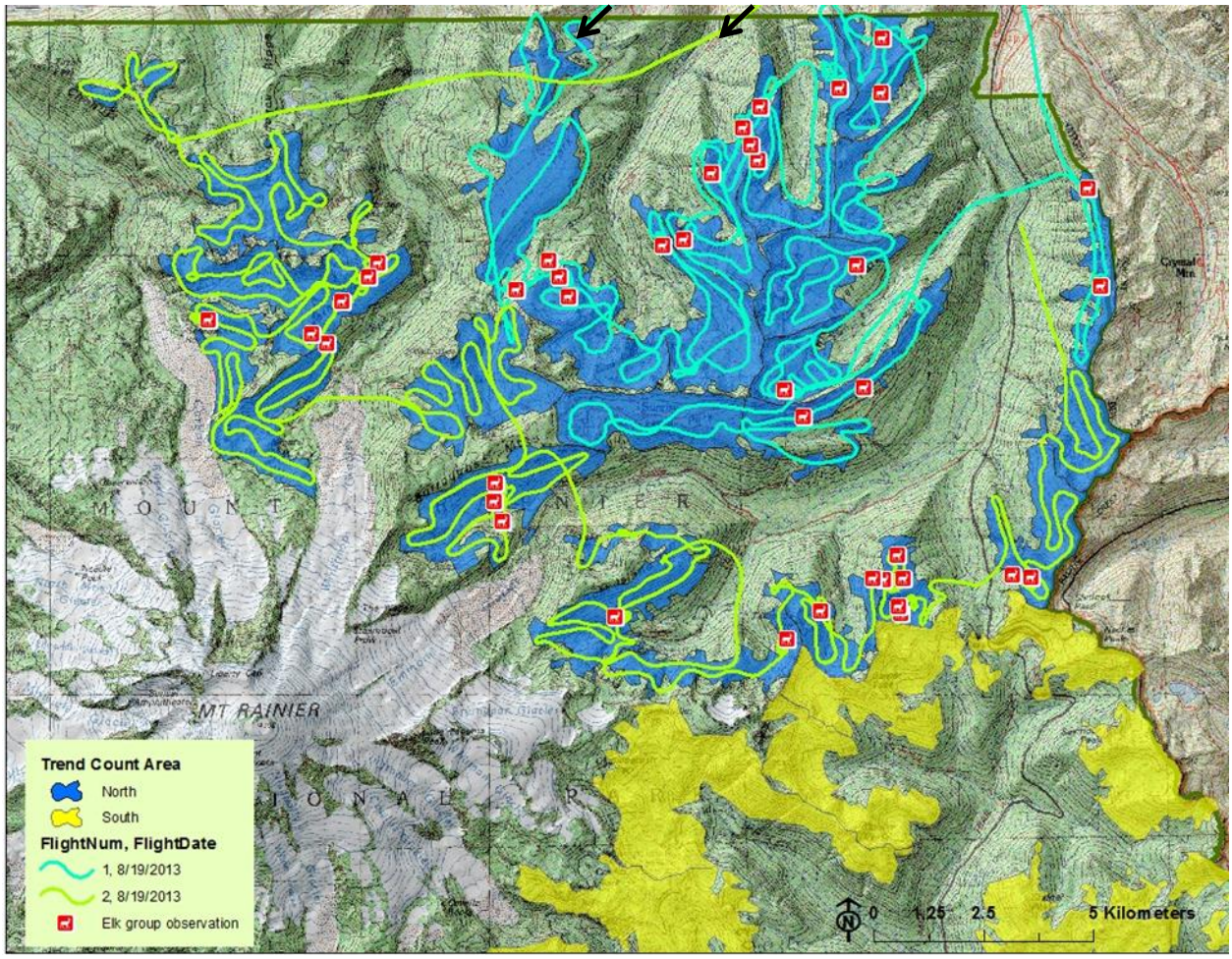

Figure 5. Flight lines (aqua=flight 1, green=flight 2) for the first replicate survey in the North Rainier trend count area, conducted 19 August 2013. Both flights originated and ended north of the survey area; black arrows indicate the start point and the flight path direction for each flight line. Approximate locations of observed elk groups are indicated with the red icon.

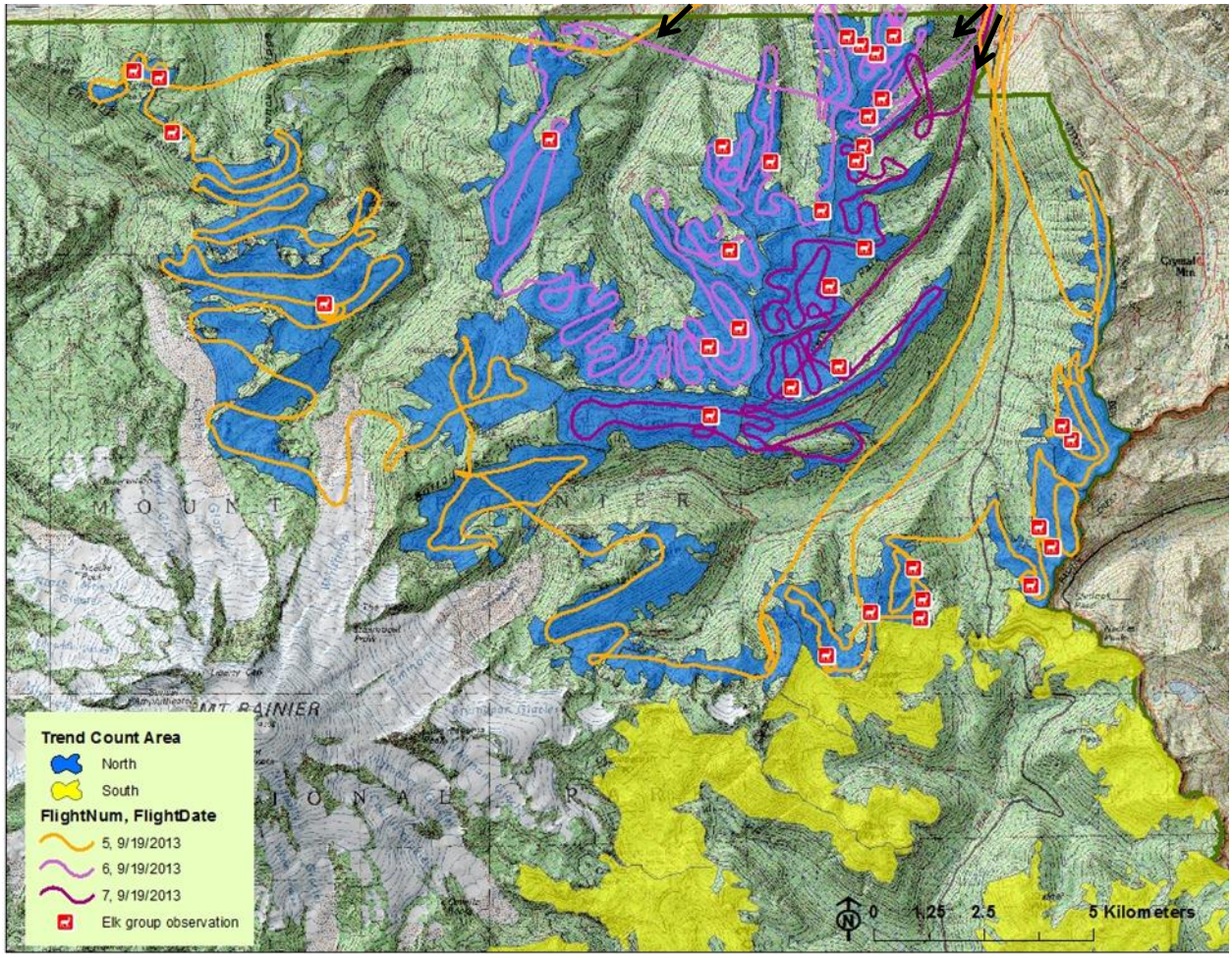

Figure 6. Flight lines (orange=flight 3, light pink= flight 6, dark pink=flight 7) for the second replicate survey in the North Rainier trend count area, conducted 19 September 2013. All flights originated and ended north of the survey area; black arrows indicate the start point and the flight path direction for each flight line. Approximate locations of observed elk groups are indicated with the red icon.

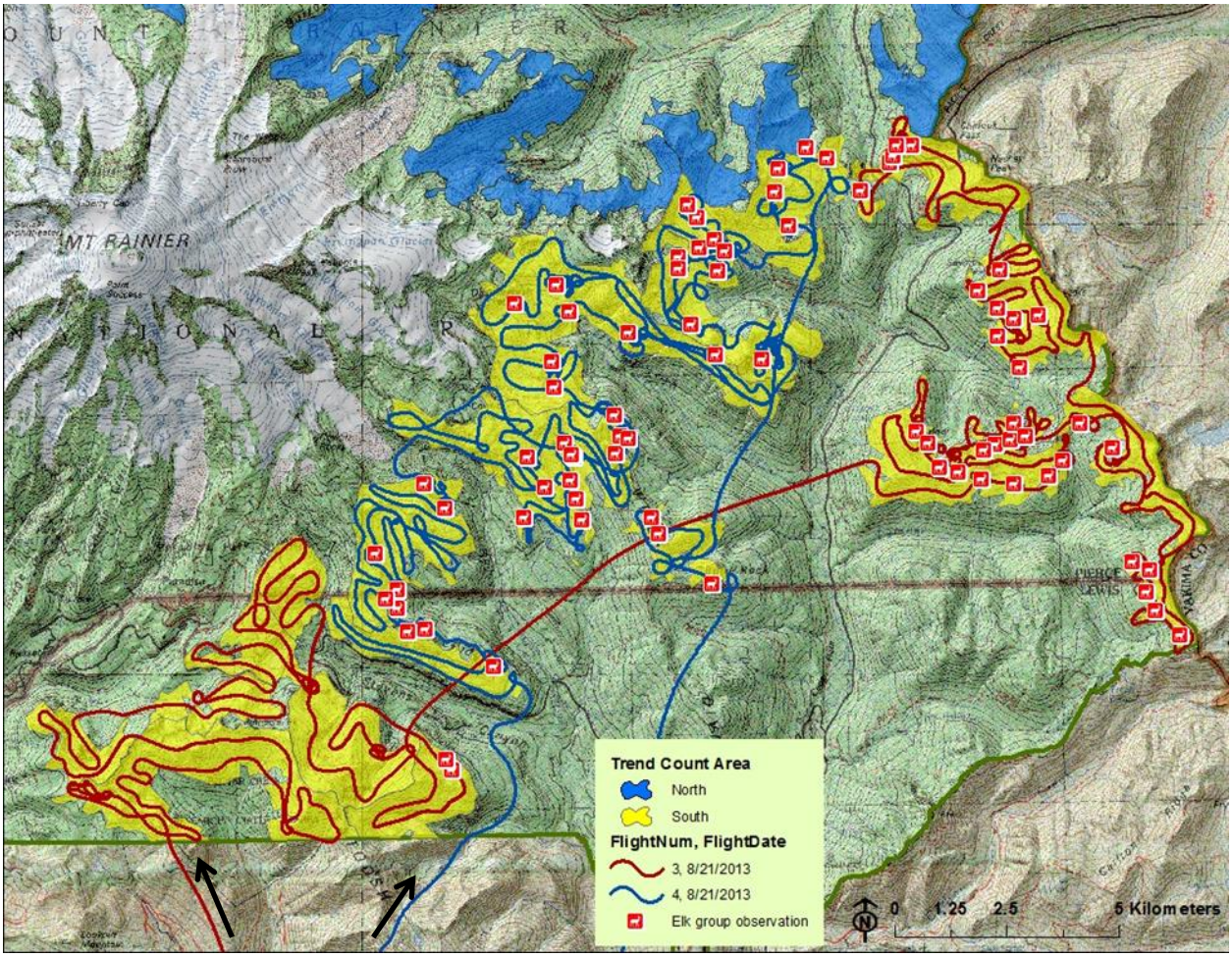

Figure 7. Flight lines (brown=flight 3, blue=flight 4) for the survey in the South Rainier trend count area, conducted 21 August 2013. All flights originated and ended south of the survey area; black arrows indicate the start point and the flight path direction for each flight line. Observed elk groups are indicated with the red icons.

Table 4. Summarized elk observations from two replicate surveys of the North Rainier trend count area, and one survey of the South Rainier trend count area. Counts include elk seen in the counts of each survey unit and a 300m buffer around each unit.

Trend Count Area	Groups	Total Elk	Cows	Calves	Bulls			Calves per 100 Cows	Bulls per 100 Cows	Mean Group Size	Max. Group Size
					Spike	Sub-adult	Mature				
South Rainier	80	505	307	94	8	11	85	30.6	33.9	6.3	111
North Rainier (Rep. 1)	40	263	133	58	8	11	27	43.6	34.6	6.6	59
North Rainier (Rep. 2)	34	106	57	22	0	13	11	38.6	42.1	3.1	9

Olympic National Park Summer Surveys

Figure 8 shows the flight paths and location of elk groups observed during the summer in OLYM. Counts and composition of elk groups seen in OLYM surveys are summarized in Table 5. We counted 243 elk in the Core and 90 in the Southeast. 2013 was the first time we surveyed in the Southest trend count area. No elk were seen in the northern count unit (SE1) and none were seen on the eastern edge of the trend count area (Figure 8). During the 2013 flights, mean group size ranged from 10 to 6.8; we encountered only a few large groups in 2013. Only four groups were greater than 30 elk, and one of those was outside (below) the survey area. The largest group observed was 54 in the Core.

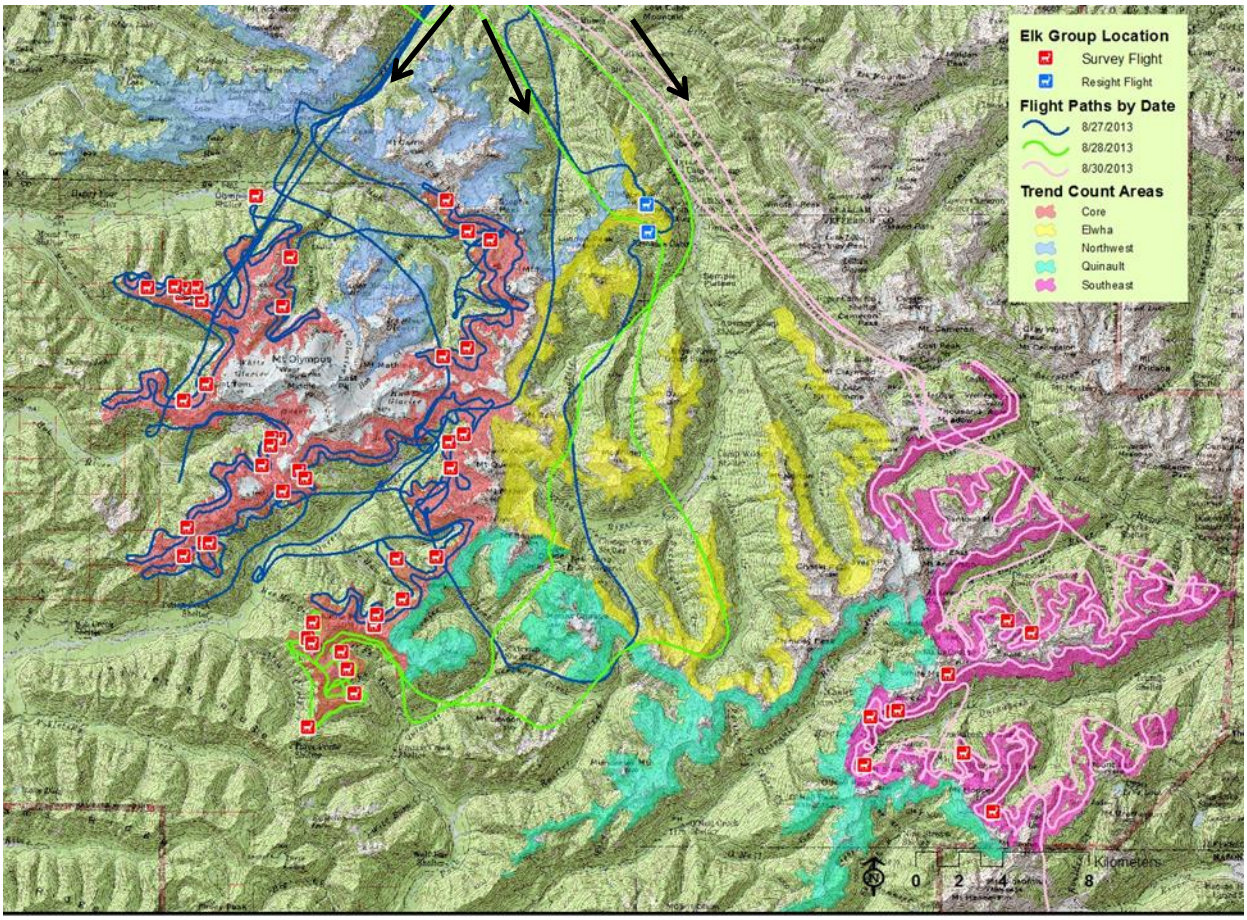

Figure 8. Flight lines in the summer trend count areas of Olympic National Park (blue=flights 1, 2, and 3; green=flight 4; pink = flights 5 and 6) conducted 27-30 August 2013. All flights originated and ended north of the survey area, with the exception of the last flight on 8/30; flight 6 ended south of the survey area. Black arrows indicate the start point and the flight path direction for each flight line. Approximate locations of observed elk groups are indicated with the icons (red=elk groups seen during the survey flight, blue=elk groups seen during additional flights conducted to collect resight data).

Table 5. Summarized elk observations from summer surveys in Olympic National Park. Counts include elk seen in the survey unit and a 300m buffer around each unit.

Trend Count Area	Groups	Total Elk[1]	Cows	Calves	Bulls			Calves per 100 Cows	Bulls per 100 Cows	Mean Group Size	Max. Group Size
					Spike	Sub-adult	Mature				
Core	36	243	108	37	3	9	45	34.3	52.8	6.8	54
South-east	9	90	46	16	7	3	18	34.8	60.1	10	42

[1] includes unclassified animals.

In addition, we completed eight resighting trials (i.e., aerial surveys conducted over groups with radio-collared elk). Of eight opportunities to see collared groups during these surveys, we detected seven groups and missed one. A total of 47 resighting trials have been collected, and thus we have completed collecting resight data and initated the the model development phases for OLYM.

Elk Abundance and Composition Estimates

Mount Rainier Summer Surveys

We applied the double observer sightability model to the 2013 MORA survey data (Table 6). After using the model to adjust for sightability**,** the estimated abundance of calves per 100 cows decreased slightly below the raw number counts, while the estimated abundance of bulls increased over raw counts.

Table 6. Raw and estimated numbers of elk and herd composition in the 2013 Mount Rainier National Park summer surveys.

Trend Count Area	Total Elk Seen	Estimated Abundance	Raw Calves per 100 Cows	Estimated Calf:100 Cow	Raw Bulls per 100 Cows	Estimated Bull:100 Cow
South Rainier	501	**600.24**	30.62	**28.86**	33.88	**38.26**
North Rainier (Replicate 1)	247	**311.95**	43.61	**42.73**	34.59	**43.19**
North Rainier (Replicate 2)	106	**160.81**	38.60	**36.26**	42.11	**42.77**

The double observer sightability model has been applied to the MORA survey data from 2008 through 2013 (Figures 9-11). Trend analyses of the 2008-2011 survey data will be presented in a forthcoming 4-year synthesis report. Data from the 2013 MORA surveys will be analyzed in the subsequent 4-year synthesis report.

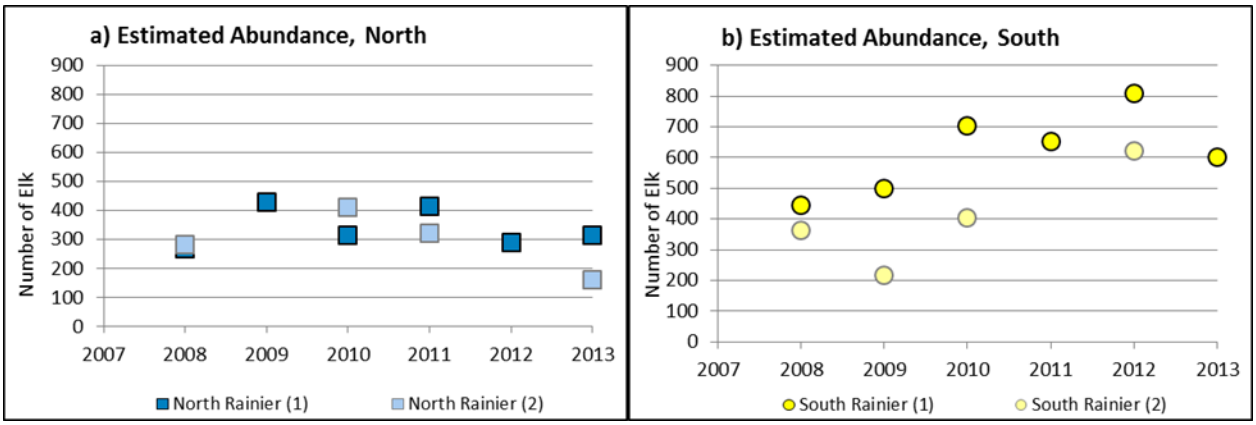

Figure 9. Estimated abundance in the a) North Rainier and b) South Rainier herd surveys, 2008-2013.

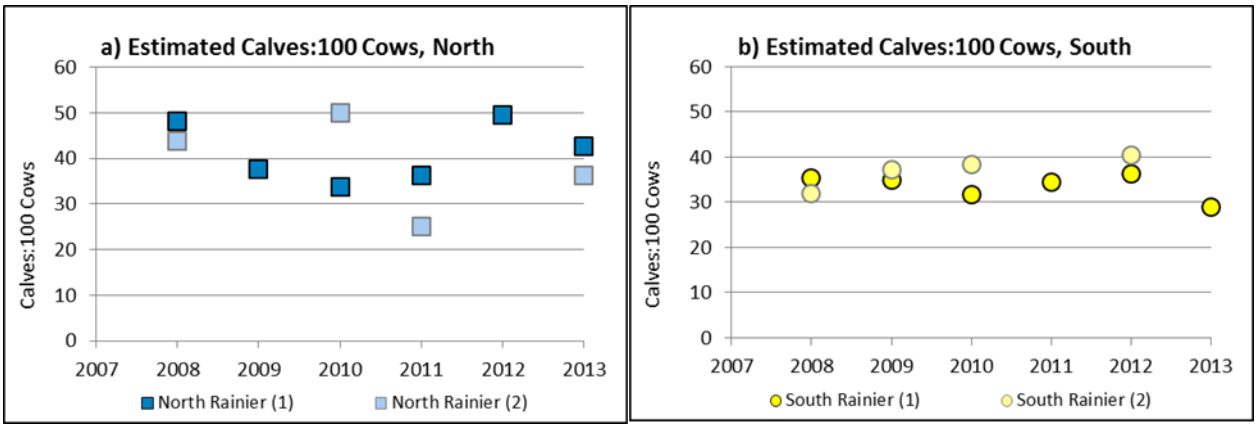

Figure 10. Estimated calves:100 cows in the a) North Rainier and b) South Rainier herd surveys, 2008-2013.

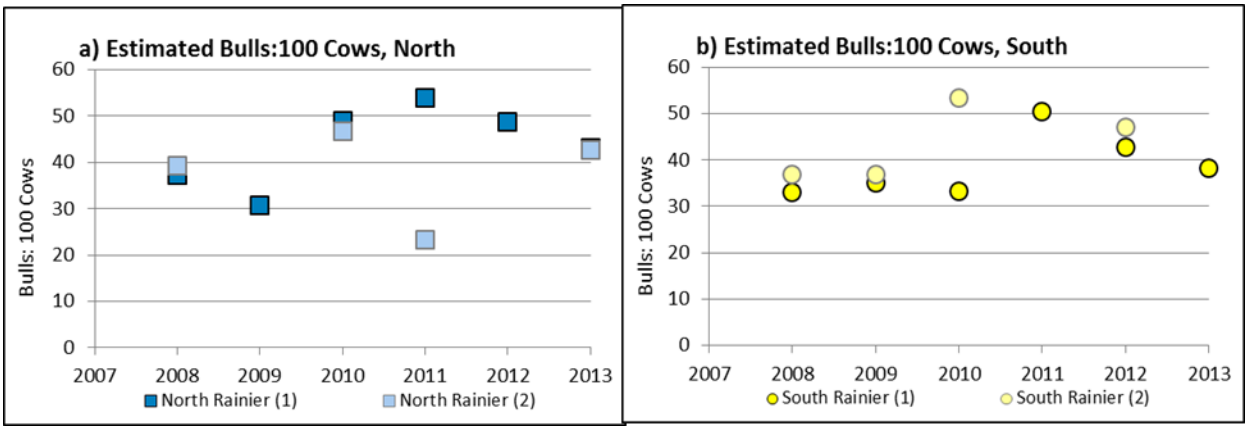

Figure 11. Estimated bulls:100 cows in the a) North Rainier and b) South Rainier herd surveys, 2008-2013.

Olympic Summer Surveys

At this stage of the monitoring, we are unable to estimate abundance or composition values for OLYM summer surveys using the double-observer model. With the addition of the 2013 resighting data, work to complete the OLYM model is underway (Figures 12 and 13). Estimates of abundance and composition will be undertaken retroactively for 2008-2013 once the OLYM model is completed and will be provided in a future annual report.

Figure 12. A group of elk, including radio-collared cow (red collar, near snag), surveyed in the upper Duckabush, part of the Southeast Trend Count Area of Olympic National Park. Photograph by Patti Happe, Olympic National Park.

Figure 13. Part of a group of elk, including a radio-collared cow (not visable), surveyed near Skyline Ridge, part of the Core Trend Count Area of Olympic National Park, WA. Photograph by: Patti Happe, Olympic National Park.

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Appendix A: Other wildlife recorded during elk surveys in Mount Rainier National Park, 2013.

Survey Area (flight)	Species	Numer of groups recorded	Number of individuals recorded
North 1 (Flight 1)[1]	Black Bear	2	2
	Deer	1	1
	Mountain Goat	4	15
North 2 (Flights 6 & 7)	Black Bear	2	2
	Coyote	1	1
	Deer	1	1
	Mountain Goat	6	40

1= other wildlife were only recorded on flights conducted by the National Park Service.

Appendix B: Other wildlife recorded on elk surveys in Olympic National Park, 2013.

Survey Area	Species	Numer of groups recorded	Number of individuals recorded
Core	Black Bear	13	14
	Black-tailed Deer	4	4
	Mountain Goat	19	31
	Golden Eagle	1	1
Southeast	Black Bear	5	5
	Black-tailed Deer	8	19
	Mountain Goat	4	9
	Golden Eagle	1	1